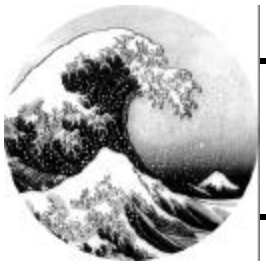


BACKGROUND PAPER #3: LAND USE PLANNING

INTRODUCTION

This paper describes how risk from tsunami hazards can be mitigated by avoiding or minimizing the exposure of people and property through land use planning. It examines the types, patterns, and densities of uses that could and should be allowed within potential tsunami inundation areas based on a consideration of the risk. This paper concentrates on large-scale land use planning issues, such as those that are dealt with in comprehensive plans, zoning ordinances, and subdivision regulations.

The paper starts with an overview of existing regulations and programs, including: statewide land use and coastal planning regulations and programs; special regulations, including the Coastal Zone Management (CZM) Program and the National Flood Insurance Program (NFIP); and descriptions of several local land use planning approaches that have been used by coastal communities to minimize or avoid tsunami hazards.

Next, the paper discusses the comprehensive planning process and the considerations that should be taken into account when formulating a community land use strategy for tsunami mitigation. Finally, the paper discusses specific land use planning measures for tsunami mitigation.

KEY CONCEPTS AND FINDINGS

There are three key concepts for land use planning in this background paper. The basic principle underlying this discussion is that development should be prevented or limited in high hazard areas wherever possible. Where development cannot be prevented or limited, land use density, building value, and occupancy should be kept to a minimum. Where these are not available strategies, and development will occur in possible tsunami inundation areas, planners and designers must look to mitigation through site planning as discussed in Background Paper #4 and/or building construction techniques as discussed in Background Paper #5.

Concept 1: New Development Should Be Avoided in Tsunami Hazard Areas

Land use and site planning should emphasize keeping new development out of hazard areas. Hazard areas should be kept as open space and may incorporate physical barriers such as landscape, berms, and engineered walls to slow and steer run-up (see Background Paper #4).

Concept 2: New Development that is Located in Hazard Areas Should Be Designed to Minimize Future Loss

When projects are built in hazard areas, communities can use a variety of land use planning and site planning methods to minimize damage. Land use planning measures include low-density and

clustered development. Site planning measures include elevating inhabited floors above inundation levels; providing barriers to block inundation; and spacing and orienting buildings to avoid the full force of a tsunami on themselves and surrounding structures (see Background Paper #4, *Site Planning* for a more detailed discussion of these topics).

Concept 3: Existing Urbanized Development in Hazard Areas Should Be Redeveloped, Retrofitted, or Recycled into Other Uses

Over time, or as a result of tsunamis, communities are finding ways to recycle and retrofit existing urbanized areas at risk. They are moving higher density uses and critical facilities out of dangerous areas, adding protective barriers, and retrofitting structures.

OVERVIEW OF EXISTING REGULATIONS AND PROGRAMS

Land Use and Coastal Planning

All five Pacific states require local land use planning, and all except for Alaska have statewide planning guidelines (Alaska has statewide planning guidelines for coastal resource districts). California, Oregon, and Washington require hazard mitigation as part of their general land use planning process. Alaska requires it for coastal resource district plans only. Hawaii only suggests that this topic be addressed.

The following is a summary of land use and coastal planning requirements related to natural hazards from Background Paper #2.

Alaska

The State of Alaska specifies the elements of local land use plans for coastal resource (coastal plans), and requires a hazard mitigation element for these plans.

The Alaska Coastal Management Program (ACMP) requires that projects in Alaska's coastal zone be reviewed by coastal resource management professionals and found consistent with the statewide standards of the ACMP in a "consistency review process." Among the topics required to be addressed are "geophysical hazard areas," including tsunami run-up areas.

California

The State of California requires every community's general plan to include a "safety element." Tsunamis are specifically mentioned as a hazard to be addressed, where applicable.

The California Coastal Management Program (CCMP) under the California Coastal Act requires each city or county lying wholly or partly within the coastal zone to prepare a Local Coastal Plan (LCP). While the specific contents of Local Coastal Plans (LCPs) are not specified by state law, LCPs must be certified by the Coastal Commission as consistent with policies of the Coastal Act. The Coastal Act (Public Resources Code, Division 20) has provisions relating to geologic hazards, but does not mention tsunamis specifically. Section 30253(1) states that "new

development shall minimize risks to life and property in areas of high geologic, flood, and fire hazard."

Hawaii

The State of Hawaii suggests but does not require that a hazard mitigation element be included in state-mandated local comprehensive plans.

The Hawaii Coastal Zone Management (CZM) Program requires that communities address coastal hazards, including tsunamis. Other key areas of the CZM Program include: a permit system to control development within a Special Management Area (SMA) managed by the counties and the Office of Planning; and a Shoreline Setback Area which serves as a buffer against coastal hazards and erosion, and protects viewsheds. A major objective of the CZM Program is to reduce hazard to life and property from tsunamis, storm waves, stream flooding erosion, and subsidence.

Oregon

The State of Oregon requires that hazard mitigation be addressed in the required local comprehensive plans (under Goal 7: Areas Subject to Natural Disasters and Hazards). It requires that jurisdictions apply "appropriate safeguards" (floodplain zoning, for example) when planning for development in these areas.

The Oregon Coastal Management Program (OCMP) is part of Oregon's statewide program for coordinated land use planning. Existing policies do not address seismic hazards and resultant tsunami hazards in any significant way.

Washington

Counties and cities required to complete a comprehensive plan are required to designate "critical areas," including geologically hazardous areas, and adopt regulations that preclude incompatible land uses or development in these areas.

The Washington Shoreline Management Act (SMA) requires that all shoreline uses and activities be consistent with the SMA and requirements of the local Shoreline Management Plan (SMP). The SMA does not contain any references to geologic or tsunami hazards. Washington Administrative Code (WAC) Chapter 173-16-Shoreline Management Act Guidelines For Development of Master Programs only mentions geologic hazards in the context of siting oil and gas facilities.

Special Regulations

As discussed in Background Paper #2, the Coastal Zone Management (CZM) Program is a partnership between the federal government and the U.S. coastal states and territories to preserve, protect, develop, restore, and enhance the resources of the coastal zone. Hazard mitigation is one of the management objectives of the program.

While state participation in the CZM Program is voluntary, there are federal funding incentives. Local compliance with the state plan is mandatory once a state has an approved Coastal Management Program (CMP). The CZM Program uses a generalized "goals" approach, meaning that State CMPs are required to meet national CZM Program goals.

As discussed in Background Paper #2, the National Flood Insurance Program (NFIP), administered by the Federal Insurance Administration (FIA) of the Federal Emergency Management Agency (FEMA), makes federally-backed flood insurance available in communities that adopt and enforce floodplain management ordinances to reduce future flood losses. The NFIP defines specific regulatory standards that local communities are required to meet to participate in the program. This "standards" approach is much more specific than the "goals" approach of the CZM Program and requires, for example, communities to regulate structural design standards.

Case Studies: Local Land Use Planning Examples

Following are descriptions of several local land use planning approaches used by coastal communities to minimize or avoid tsunami risks. These communities, all in Alaska and Hawaii, have sustained tsunami damage and put measures into place to mitigate future tsunami risks. The information is based on the case studies in *Land Management in Tsunami Hazard Areas* (1982) and other background documents, and on interviews with local planners conducted in fall 2000 by Mintier & Associates.

It is interesting to note that both the County of Hawaii and the County of Kauai had special overlay zones in their respective zoning codes that applied to tsunami hazards, but this approach was abandoned in time in favor of building design regulations as part of flood hazard ordinances administered by their public works departments. The overlay zoning approach was considered ineffective. The City and County of Honolulu (see case study in Background Paper #4) also addresses tsunamis through building construction and design regulations in its flood hazard ordinance. All the regulations aim at ensuring that structures withstand tsunami forces; however, they do not contain criteria to determine which uses are appropriate in the hazard zone.

The Alaskan communities have used a variety of approaches. Valdez moved their entire town after the 1964 earthquake and tsunami. Seward rezoned its waterfront for open space (park) uses. Kodiak did not adopt the more comprehensive response that they drafted, but instead has addressed the hazard through construction and design regulations in its Coastal Management Program. It is also interesting to note that all of the Alaskan communities, except for Seward, officially challenged the "high-risk" classification of land established by the Federal Reconstruction Commission for Alaska.

North Shore of Kauai Island, Hawaii

Kauai is the most northwestern of the principal Hawaiian islands. The North Shore of Kauai is relatively sparsely settled. Land uses includes agriculture, low-density residential, and commercial/resort uses around Hanalei. Access to the area is from the Kuhio Highway which

extends from Lihue, the capital, to Haena at the western end of the North Shore. Portions of the highway are within the tsunami inundation zone.

The North Shore area is susceptible to tsunamis from both the north and south and has experienced frequent tsunami events. The North Shore experienced four large tsunami events in recent history. Each of these was distantly generated, with the 1946, 1957, and 1964 events originating in the Aleutian Island area of Alaska, and the 1960 event originating offshore of Chile.

The 1946 tsunami event in Kauai resulted in ten people dead, five missing, and eight injured, with 60 homes destroyed and 130 damaged. The wave run-up reached a maximum elevation of 45 feet, although the run-up elevation varied considerably across the inundation area because of reef and shoal protection. The 1957 tsunami destroyed 54 homes and damaged another 27. In addition, several public buildings and six bridges were damaged, with one bridge completely destroyed.

The Kauai General Plan was adopted in 1970 and updated in 1984. It is currently being revised and is scheduled for adoption by the end of 2000. The General Plan established four "Development Restriction Zones" for: 1) steep slopes; 2) areas subject to tsunami inundation; 3) areas subject to flooding; and 4) inadequate soil conditions. The General Plan policies continue the existing land use patterns to a large degree with low-density residential uses concentrated in the coastal areas, and agriculture and resort activity in the upland areas. All private land uses in the Hanalei Bay area are within the inundation zone.

The 2000 General Plan Update Draft contains policies and recommends implementing actions to limit development on shoreline lands within coastal flood hazard areas. These policies were developed more for hurricane mitigation than tsunami mitigation, but are still applicable to tsunami hazards. Hurricane Iniki in 1992 and Hurricane Iwa in 1982 caused a great amount of damage on Kauai and are much stronger memories than the last tsunami to cause significant damage on Kauai in 1957.

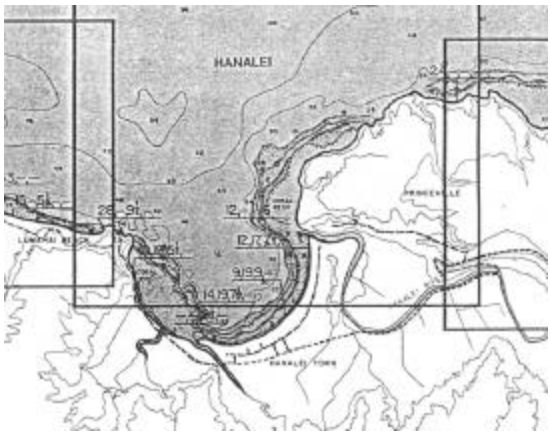
The proposed policies in the General Plan Update are as follows:

> *"Establish zoning and subdivision regulations that (1) strictly limit development on lands that are steeply-sloped and/or have highly erodible soils, in order to prevent flooding, landslides and nonpoint pollution; and (2) strictly limit development on shoreline lands within coastal flood hazard areas or susceptible to shoreline erosion."*
>
> *"The Planning Department shall review and revise the Subdivision Ordinance and the Comprehensive Zoning Ordinance, including the regulations for the Open District and the Constraint Districts, in order to: (1) assure effective regulation of steeply-sloped lands and drainageways; and (2) eliminate ineffective regulations and reduce unnecessary application requirements."*

The North Shore Development Plan was adopted in 1974 and updated in 1985 to address development in the North Shore area of the county. It includes zoning designations, a utilities and circulation plan, a recreation plan, and an implementation program consisting of urban design standards and recommended capital improvements. Approximately half of the tsunami

hazard zone is designated low-density residential. All developments within the hazard zone fall within the special Tsunami Constraint District as an overlay zone in the Zoning Code. The overlay zone was intended to restrict development in the tsunami zone by not allowing public buildings intended for human habitation, schools, hospitals, nursing homes, and other similar uses. Additional requirements relating to public utilities, industrial uses, and hazardous materials were also to be specified. However, the Tsunami Constraint District has never been implemented and there are no additional development standards with which projects are required to conform.

The North Shore Plan proposed the creation of an additional resort/residential center outside of the tsunami zone on a plateau in the Princeville area east of Hanalei. The plan also proposed establishing medical facilities and moving the community's fire station and elementary school out of the tsunami hazard zone.



Excerpt from map of tsunami run-up heights in the Kauai North Shore Plan.
Credit: County of Kauai

The County adopted a Flood Damage Prevention Ordinance in 1981 to meet federal flood insurance requirements. The ordinance establishes minimum floor heights above flood levels and other structural requirements. The County, in response to the damage caused by Hurricane Iniki in 1992, adopted a new Flood Plain Management Ordinance in 1995. It is based on a 1994 study by the Federal Insurance Administration entitled *The Flood Insurance Study for the County of Kaua`i,* which included Flood Insurance Rate Maps (FIRMs). The ordinance, administered by the Department of Public Works, imposes mitigation measures on development within Coastal High Hazard Areas identified as VE zones in the FIRMs. The basic measures include raising habitable structures above the base flood elevation and more stringent construction standards.

In summary, the regulatory framework in Kauai uses a combination of low-density zoning to reduce the amount of potential property damage and development standards designed to ensure that structures will be able to withstand the wave forces.

Hilo, Hawaii

Hawaii is the most southeastern of the principal Hawaiian Islands. The city of Hilo is located on the northeast side of the island. Approximately half of the island's residents live in the greater Hilo area. Of the more than 305 miles of coastline on the island, approximately 225 miles, or 75 percent, is undeveloped cliff area that is not subject to property damage from coastal flooding or tsunami inundation.

The Hilo shoreline, which includes both Hilo Bay and the Keaukaha Coast, is one of the few coastal areas on the island that is not bordered by steep cliffs. Land uses along the coast in the Hilo area include residential and commercial/resort uses and a large port/industrial area. The main highway serving the coastline is located largely in the inundation zone.

Hilo has experienced tsunamis frequently, and, because of its orientation, is especially susceptible to tsunamis generated in the eastern and northern Pacific Ocean, including tsunamis generated from South America, the Aleutian Islands, Kamchatka, and the Kuril Islands. More than 47 tsunami events have been recorded since 1837, with 12 causing severe damage to Hilo. Run-up elevations of 35 feet were experienced in the 1960 tsunami generated off of the coast of Chile. The 1960 tsunami resulted in 61 people killed, 282 injured, and 537 buildings destroyed. The 1946 tsunami, originating in the Aleutian Islands, had wave run-ups of 27 feet and resulted in 173 people killed, 162 injured, 488 buildings destroyed, and severe damage to the breakwater.

Damage from the 1960 tsunami in the Waiakea area of Hilo, Hawaii.
Parking meters were bent by the force of the debris-filled waves.
Credit: U.S. Navy

Initial hazard mitigation efforts in Hilo from 1946 to the mid-1960s focused on offshore structural defense barriers, such as waterfront seawalls and breakwaters. These efforts were abandoned when it became clear that the aesthetic and economic costs were too high and the effectiveness of the schemes had not been adequately demonstrated.

On May 31, 1960, the County created the Hawaii Redevelopment Agency for the redevelopment or rehabilitation of the urban area devastated by the tsunami of May 23, 1960. On March 1, 1961, the County approved the Urban Renewal Plan for the Kaiko'o Project. The scope of the

Plan included: acquisition of specific real property; relocation, demolition, and removal of buildings; rezoning; and final disposition of acquired property.

The Urban Renewal Plan relocated downtown businesses destroyed in the tsunami event through a land exchange for state-owned property outside the hazard zone. The downtown shoreline area was never redeveloped and remains mostly open space today. There are hotels along the shoreline of Banyan Drive outside of the Plan area.

General plan studies in the County of Hawaii were initiated in the late 1950s on a regional basis. A *Plan for the Metropolitan Area of Hilo* was completed in 1961 for the districts of South Hilo and Puna. This plan incorporated the proposed zoning resulting from the Urban Renewal Plan. Along with two other regional plans, it was adopted in July 1965 as the General Plan for the County, but did not include all of the districts in the county. The County of Hawaii adopted its first island-wide General Plan in 1971. The current General Plan was adopted in 1989. As of fall 2000, the General Plan was being revised by the County.

The Flood Control and Drainage Section of the General Plan contains the most specific references to tsunami hazard management. One key policy in this section states:

> *"In areas vulnerable to severe damage caused by the impact of wave action restrictive land use and building structure regulations must be enacted relative to the potential for loss of life and property. Only uses which cannot be located elsewhere because of public necessity and character such as maritime activities and the necessary public facilities and utilities would be allowed." (Flood Control and Drainage Section of the Hawaii County General Plan)*

However, contrary to this policy, the 1971 General Plan map designated a large amount of the coastline for industrial, resort, and other high density uses. The 1978 revision to the General Plan changed some of these areas to open space or low-density residential uses.

Hawaii County has used the tsunami hazard risk as a basis for allocating land uses and for setting specific design and building standards. However, there has still been substantial development within the hazard area, including the Banyan Drive resort area which is located entirely within the tsunami hazard zone. There has also been considerable pressure for the development of high-density condominium complexes along the coastline.

Until it was revised in 1996, the Hawaii County Zoning Code included a Safety District Zone, which was an overlay zone that applied to hazard zone areas (e.g., tsunami, flood, and geologic). The Safety District boundaries that applied to the tsunami hazard area conformed with the inundation limits mapped in the General Plan. The Safety District is no longer part of the Zoning Code. However, potential tsunami inundation areas are still shown on General Plan Facilities Maps.

In place of this system, the County's Department of Public Works oversees construction in tsunami inundation areas as part of its responsibility in administering Chapter 27, Flood Control, of the Hawaii County Code. The tsunami inundation areas have been identified through the adoption of FEMA flood hazard maps. The following is the complete text setting out the standards for tsunami inundation areas in Chapter 27. This section was adopted in 1993.

Section 27-23. Standards for coastal high hazard areas.

Coastal high hazard areas, more commonly known as tsunami inundation areas, are identified as Zone V or Zone VE on the Flood Insurance Rate Maps. Within coastal high hazard areas, the following standards shall apply:

(a) All new construction and substantial improvements in a coastal high hazard area shall be constructed with materials and utility equipment resistant to flood damage and using methods and practices that minimize flood damage.

(b) New construction and substantial improvement shall be elevated on adequately anchored pilings or columns and securely anchored to such pilings or columns so that the lowest horizontal portion of the structural members of the lowest floor, excluding the pilings and columns, is elevated to or above the base flood level. The pile or column foundation and structure attached thereto shall be anchored to resist flotation, collapse, and lateral movement due to the effects of wind and water loads acting simultaneously on all building components. The wind and water loading values shall each have a one percent chance of being equaled or exceeded in any given year.

(c) New construction and other development shall be located on the landward side of the reach of mean high tide.

(d) New construction and substantial improvement shall have the enclosed space, if any, below the lowest floor free of obstructions and constructed with breakaway walls as defined in section 27-12. Such enclosed space shall not be used for human habitation and will be useable solely for parking of vehicles, building access, or storage. Machinery and equipment which service the building, such as furnaces, air conditioners, heat pumps, hot water heaters, washers, dryers, elevator lift equipment, electrical junction and circuit boxes, and food freezers are not permitted in such enclosed spaces. The enclosed space must only be achieved with breakaway walls, open wood lattice-work, or insect screening intended to collapse under wind and water loads without causing collapse, displacement, or other structural damage to the elevated portion of the building or supporting foundation system. A breakaway wall shall have a design safe loading resistance of not less than ten and no more than twenty pounds per square foot. Use of breakaway walls which exceed a design safe loading resistance of twenty pounds per square foot may be permitted only if a registered professional structural engineer certifies that the design proposed meets the following conditions:

1) Breakaway wall collapse shall result from a water load less than that which would occur during the base flood; and

2) The elevated portion of the building and supporting foundation system shall not be subject to collapse, displacement, or other structural damage due to the effects of wind and water loads acting simultaneously on all building components (structural and nonstructural). Maximum wind and water loading values to be used in this determination shall each have a one percent chance of being equaled or exceeded in any given year (one-hundred-year mean recurrence interval).

(e) Fill shall not be used for structural support of buildings.

> *(f) Man-made alteration of sand dunes which would increase potential flood damage is prohibited.*
>
> *(g) All new construction, development, and substantial improvement within coastal high hazard areas shall be certified as required by section 27-17.*

The Hilo Community Development Plan (CDP) was adopted in 1975 to implement the Hawaii County General Plan in the greater Hilo region. For the Hilo area, the Hawaii Zoning Code is based on the land use designations and policies of the CDP. Some of the major provisions in the CDP regarding tsunami hazards are as follows:

- Minimize major new development of the ocean side of the 100-year tsunami inundation line through zoning and purchase for recreational uses;

- Require any development that does occur within the inundation zone to comply with the following design criteria: 1) buildings should be designed so that a tsunami will pass under them or wash through areas not intended for human occupancy; 2) buildings should be oriented to present their narrowest sides to a tsunami; 3) buildings should be sited on the highest natural elevation of their lot and earth platforms to gain foundation elevation;

- Expand the tsunami control forest as an attractive landscaped recreation area along the Bayfront to dissipate the energy of future tsunamis; and

- Develop a recommended extensive open space network along the shoreline area.

No significant tsunami control forest was ever developed. The shoreline area within the Kaiko'o Project area continues to be part of an extensive open space network that consists of a privately-owned golf course, county-owned park areas (passive recreation uses along with soccer and softball fields, and other facilities), and state-owned park areas.

Kodiak, Alaska

The Kodiak Island Borough includes a group of approximately 200 islands located off the southeast side of the Alaska Peninsula and all of the land on the Alaska Peninsula that drains into Shelikof Strait, from Cape Douglas in the north to Wide Bay in the south. In addition, Chirkof Island and the Semedi Islands are also located in the Borough. The city of Kodiak is the largest community in the Borough and is located on the northeastern shore of Kodiak Island, the largest island in the Borough.

The city of Kodiak has experienced numerous tsunamis over the past 200 years. However, only one produced waves large enough to cause property damage or casualties. While the 1960 Chilean tsunami only produced approximately a two-foot rise in the water level at Kodiak, the Great Alaska Earthquake of 1964 generated a large tsunami originating on the continental shelf in the Gulf of Alaska. Although the city of Kodiak experienced large amounts of groundshaking from the earthquake, the earthquake shocks caused only minor damage. The resultant tsunami, however, destroyed approximately 80 percent of Kodiak's downtown area and destroyed or damaged many other smaller settlements in the Kodiak Island Borough.

Damage from the 1964 tsunami in Kodiak, Alaska.
Credit: NOAA

The 1964 tsunami destroyed 158 houses and numerous other structures in the city of Kodiak, including docking facilities, Naval Station structures, and commercial buildings. In addition, most of the fishing vessels in the harbor were destroyed, as the tsunami turned them into projectiles that caused much of the other property damage in downtown Kodiak. After the tsunami event, the city decided to rebuild the commercial core of Kodiak in the same place where it had been. However, this required filling the land area that had subsided by 6.5 feet due to the earthquake. A breakwater was also built to reduce wave-generated erosion and to protect the reestablished boat harbor.

The Kodiak Island Borough Regional Plan and Development Strategy was proposed in 1978 as an update to the Kodiak Island Borough Comprehensive Policy and Land Use Plan (its comprehensive plan). The 1978 plan recommended the creation of a second business district near the rebuilt commercial core but outside of the tsunami experience zone. It also called for the expansion of industrial facilities in the tsunami hazard zone. However, the Regional Plan and Development Strategy was never adopted. The Borough is still using the 1968 version of the comprehensive plan for the downtown Kodiak core area. A second business center, quite a distance outside the downtown core, has been recently established, however, due to substantial community growth occurring north of the city of Kodiak.

While the Zoning Code does not include a special safety or tsunami district, the Borough has adopted a Coastal Management Program (CMP) that includes performance-based standards for tsunami hazard areas. The standards are specifically applied only to those activities that require review by the Kodiak Island Borough Planning and Zoning Commission (e.g., conditional use permits and subdivision reviews) and are deemed consistent with the zoning code and building code for staff-level permitting. Therefore, the performance standards have been applied primarily to outlying areas.

Construction in the port area emphasizes the utilization of the waterfront for non-habitable uses. The Kodiak Port and Near Island Master Plan has several provisions to mitigate tsunami risk, including the stabilization of Pillar Mountain against landslides that could create a locally-generated tsunami, the creation of several breakwaters, and the recommendation to locate residential uses outside of the tsunami inundation zone. In addition, critical facilities such as

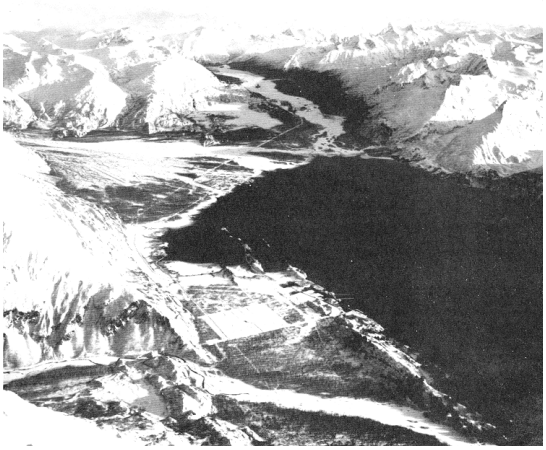
schools, and police and fire stations have been located in upland areas outside of the tsunami hazard zone. An interesting note is that in Kodiak, as in many Japanese communities, the industrial waterfront buildings are not designed to withstand tsunami forces and are treated as cheap throwaway structures. Economic considerations regarding the upgrading of these buildings to meet flood standards has been one reason why Kodiak has not participated in the National Flood Insurance Program.

Valdez, Alaska

Valdez is a town of approximately 4,500 people located at the head of Port Valdez. It is Alaska's northernmost ice-free port and is the southern terminus of the Alaskan pipeline and the Richardson Highway.

The Great Alaska Earthquake of 1964 triggered a massive submarine slide that completely destroyed the harbor facilities and nearshore installations in Valdez. Additionally, portions of the shore subsided below high-tide level and the entire area experienced strong groundshaking. Waves generated by the submarine slide and the earthquake itself did additional damage. Damage to the harbor and port facilities alone was estimated at almost $3.6 million in 1964 dollars.

The Federal Reconstruction Commission decided to abandon the old town site and reconstruct Valdez on a site four miles northwest of the old city because the old site was considered extremely vulnerable to future sliding, ground cracking, and flooding. This relocation was accomplished using urban renewal mechanisms, including the acquisition of land at the old site and development of the new site.



The old townsite of Valdez in the background and the new site in the foreground.
Credit: U.S. Army Corps of Engineers

The renewal plan called for public open space and park and recreation uses as the only allowed uses on the old site. No permanent structures were to be allowed in this area, although buildings could be relocated to the new site. The recreation uses were never developed, however, and part of the old site is used as a staging area for truck and barge shipping and large construction projects. Another part contains the city's sewage treatment facility and solid waste bailer facility, with the remainder of the land vacant. The City owns the old site and the land use restrictions

imposed by the renewal plan will be lifted in 2014. The City does not plan to change the nature of uses on the site, however, and will continue to restrict high-impact, high-density uses.

Valdez is an example of completely changing land use in an area following a disaster and rebuilding in a new place to avoid the hazard in the future.

Seward, Alaska

The town of Seward is located at the head of Resurrection Bay on the southeast coast of the Kenai Peninsula. It is one of the few ice-free ports in south-central Alaska and provides year-round access from the coast to inland areas by railroad and highway. It is the southern terminus of the 470-mile long Alaska Railroad.

The Great Alaska Earthquake of 1964 completely destroyed Seward's harbor, shipping, and fishery facilities, which were the economic base of the town. Both the railroad yard and seaport facilities sustained heavy damage. The twelve fatalities in Seward during the earthquake were due to the local and the main tsunamis.

Seward is sited on an alluvial fan delta, and shortly after the groundshaking started, progressive sections of the waterfront slid into Resurrection Bay due to large-scale offshore sediment slump of the delta front. This submarine landsliding generated a series of local tsunamis that arrived within one to two minutes after the onset of the earthquake. The combined slump and tsunami caused the collapse of the dock fronts and the sinking of some boats within the harbor. Approximately 20 minutes after the earthquake began, the first wave of the main tsunami arrived and caused additional damage.

Fires erupted almost immediately after the earthquake began when a tank collapsed at the Standard Oil tank farm. A Texaco oil installation also ruptured and burned for days afterward. The tsunami spread the burning oil that was floating on the water. Tsunami run-up was up to 30 feet at the north end of Second Street. The Alaska Railroad yards were heavily damaged as were freight units in the yards. Most of the railroad dock was washed away by the waves. The railroad also lost two cranes and its waterfront tracks as rails were stripped from railroad ties by the tsunami.

Damage to the railroad facilities at Seward Port from the 1964 tsunami.
Note the fire-damaged oil storage tanks.
Credit: NOAA/NGDC

It is estimated that 95 percent of Seward's industrial base was lost due to earthquake and tsunami damage. Fifteen percent of the town's residential properties were either totally destroyed or very heavily damaged. Total damage to public and private facilities was estimated at approximately $22 million in 1964 dollars.

An urban renewal plan for the revitalization of the community was prepared shortly after the disaster; however, the project boundaries were narrowed by the Federal Reconstruction Commission to include only the damaged waterfront area. The docks and harbor were relocated, and the Alaska Railroad facilities were reconstructed. No permanent habitable structures are allowed in the high-risk area along the waterfront, although there are public restroom facilities located there. Most of this area was publicly owned before the disaster, and acquisition was not a problem.

Seward rezoned the waterfront area for open space (park) uses. The land remains in park use and is used as an RV park in the summer. Although it is unlikely that any major permanent structure would be built in this high risk area, the waterfront is zoned for park uses and the Zoning Code allows "Permanent Visitor Attractions" and "Senior/Teen/Community/Civic Centers" in the Park Zone by conditional use permit. The harbor, docks, and other facilities that were moved to the head of the bay are still considered to be at risk from future tsunamis and flooding.

Seward has participated in FEMA's National Flood Insurance Program (NFIP) since 1986 under the Kenai Peninsula Borough. Seward adopted its own floodplain management ordinance in 1998. The ordinance addresses coastal high-hazard areas (V zones).

Burning petroleum storage tanks along the Seward, Alaska, waterfront after the 1964 tsunami and earthquake.
Credit: Anchorage Museum of History and Art

COMPREHENSIVE PLANNING PROCESS

The following describes the considerations that should be taken into account when formulating a community land use strategy for tsunami risk mitigation.

Understand Locational Context

The importance of locational context for land use planning decisions must be understood. Opportunities for reducing tsunami risk differ depending on local circumstance, so a one-size-fits-all approach cannot be used. The presence or absence of development within tsunami hazard areas will determine the type of planning approach that is feasible. For example, vacant land conversion, such as expansion of an existing community or development of a new community, will require different mitigation strategies than will other forms of development such as infill, redevelopment, reuse, or changes in occupancy.

Understand Trade-Offs

Mitigation often means making trade-offs between or among competing goals when dealing with land use planning issues and tsunami hazards. For example, the public access emphasis in Coastal Zone Management (CZM) programs argues for locating visitor-serving development along the coastline; yet this access can be at direct odds with public safety objectives for minimizing new development in tsunami inundation areas.

Coastal-dependent development such as ports and harbors that, by their nature, have to be situated on the coast can also conflict with safety goals. Other planning goals such as compact/dense downtowns can also result in increased risk.

Aerial view of tsunami and earthquake damage to Valdez, Alaska,
showing the extent of inundation along the coastline
from the 1964 Great Alaska Earthquake.
Coastal-dependent development can conflict with safety goals.
Credit: U.S. Department of the Interior

These trade-offs need to be recognized in the planning process. The revision process for a comprehensive plan is a good time to weigh alternatives and to balance competing goals.

Review and Update Existing Safety Element

The existing safety or natural hazards element of the comprehensive plan should be reviewed to determine if it adequately recognizes tsunami hazards and how the risk is managed when decisions are made. The following information should be inventoried and updated, as necessary:

- Technical information – such as inundation zones;
- Scenario information; and
- Goals and policies.

In addition, it should be recognized that tsunami hazards often overlap other hazards and that mitigation for other hazardous conditions can assist in mitigating tsunami risk. Such hazards might include riverine flooding, hurricanes/typhoons, landslides, coastal erosion, and earthquakes.

Erosion along the Oregon coast.
Mitigation for other hazardous conditions such as erosion, flooding, hurricanes, and seismic hazards can assist in mitigating tsunami risk.
Credit: Oregon Department of Land Conservation and Development

Review Existing Land Use Elements and Other Plans

The existing land use element, other comprehensive plan elements, and special plans should be reviewed to determine what changes are needed to address the tsunami hazard and be updated as necessary. Land use policies and programs should address tsunami hazards as part of a comprehensive tsunami mitigation program.

Such an update should focus on the location and vulnerability to damage of existing and planned land uses in the community, including the following:

- Residential;
- Commercial/visitor-serving;
- Industrial (general);
- Industrial (hazardous materials);
- Public facilities (transportation and water systems); and
- Critical facilities and systems (communication, emergency response, electrical power, water supply, and natural gas systems).

Review and Update Existing Zoning, Subdivision, and Other Regulations

Existing zoning, subdivision, and other regulations should be reviewed and updated with an eye to mitigating future tsunami losses. Requirements for consistency between the comprehensive plan and zoning and subdivision regulations vary among the states. In California for example, the zoning code is considered part of the local coastal program (LCP) for coastal communities and is required to be consistent with the general plan.

Planning for Post-Tsunami Reconstruction

Disasters create the opportunity to eliminate nonconforming uses and reshape existing patterns of development to minimize future losses. On the other hand, they can also create enormous pressure to rebuild the community quickly and exactly as it was before the disaster. These rebuilding issues should be addressed through the land use planning process before a disaster strikes so that a community is prepared to deal with rebuilding issues in the event of disaster.

In communities that have suffered tsunami damage, redevelopment can be based on planning principles that emphasize avoiding run-up areas, designing sites within run-up areas to minimize loss, and recycling and retrofitting existing urbanized areas that are at risk.

LAND USE PLANNING MEASURES

Designate Tsunami Hazard Areas for Open-Space Uses

The designation and zoning of tsunami hazard areas for such open-space uses as agriculture, parks and recreation, or natural hazard areas is recommended as the first land use planning strategy to consider. This strategy is designed to keep development at a minimum in hazard areas. It is particularly effective in areas that have not yet experienced development pressure. It is obviously more difficult in areas that are already partially developed, and/or that have strong development pressure.

Park on the Hilo, Hawaii, waterfront. Open space uses such as parks can keep development at a minimum in hazard areas.
Credit: County of Hawaii

In areas where development pressures are stronger, transferable development rights (TDR) programs may be more feasible. Transferable development rights (TDRs) are "a device by which the development potential of a site is severed from its title and made available for transfer to another location. The owner of a site within a transfer area retains property ownership, but not the approval to develop. The owner of a site within a receiving area may purchase Transferable development credits, allowing a receptor site to be developed at greater density." (State of California, Office of Planning and Research, *General Plan Guidelines*, 1998). The term "transferable development credit" (TDC), used by some communities to describe their programs, is interchangeable with TDR.

A mandatory TDR program reduces the development potential in the sending district through some form of rezoning and effectively limits or prohibits development in that area. The advantage of a TDR program is that it provides a compensation mechanism for down-zoning property. The disadvantages are that it can be difficult to administer and often slow to take hold because of initial property owner reluctance and fear. Also, suitable locations into which the transfer of increased development can be made must be chosen carefully.

Acquire Tsunami Hazard Areas for Open-Space Uses

A second strategy is to acquire tsunami hazard areas for open-space uses. Open-space acquisition has several advantages over strictly regulatory approaches such as zoning. Acquisition ensures that the land will be controlled by a public agency or non-profit entity, and it removes any question about a regulatory taking. The primary disadvantage to acquisition is cost.

There are multiple approaches to acquisition. Since land ownership is in effect a bundle of rights, including the rights to sell, lease, and develop the property, some of these rights, such as the right to develop, can be sold separately from the rest of the property.

Fee-Simple Acquisition

Fee-simple acquisition consists of acquiring all of the real property interests associated with the land. The most effective and most costly way to keep development out of a risk area is to acquire the land and retain it in public ownership as open space. Fee-simple acquisition is particularly appropriate when the use of the land requires public access, as with recreation land. In situations where the primary goal is to limit development, ownership of a full fee-simple interest may be unnecessary.

Fee-simple property acquisition can often be accomplished after a disaster when there is significant money available for disaster-relief and prevention efforts. Sale of a fee-simple interest is usually voluntary but can also be accomplished by the exercise of the power of eminent domain by a public agency. Eminent domain is a compensated "taking" of land for public use.

Purchase of Development Rights (PDR)

A purchase of development rights (PDR) program is based on purchasing the right to develop land from the bundle of rights associated with the land. A PDR program involves the purchase of

the development rights to a property, generally through the granting of a conservation, open-space, or scenic easement that restricts the uses to which the property owner may put the land. A PDR program can also be constructed to purchase a fee-simple interest in a property and then resell the property with an easement restricting future development. A similar result can be obtained through purchasing a fee-simple interest and then leasing the property with restrictions on use. PDR programs are more effective in preserving land from development where development pressure has not yet driven up land prices.

The advantages to a PDR program are that it can be less expensive than a fee-simple acquisition program (except in areas where development pressure is high), it provides a cash payment to landowners and reduces property and inheritance taxes, preserves land from development in perpetuity, and can be administered in conjunction with a non-profit agency so that a local jurisdiction does not have to assume the landlord responsibility. Disadvantages of PDR programs include the expense, and similar to TDR programs the slowness of establishing confidence and support of the program among landowners, and the damage that the program may cause to a community's ability to use regulations to limit development because of the perception that all development restrictions should be compensated.

Partial or Voluntary TDR Programs

A partial TDR program still allows some development potential in the sending area, while a complete TDR program proscribes development in the sending district. A voluntary TDR program leaves the existing zoning in place in the sending district, but allows the development rights to be transferred to the receiving district. A voluntary program could be structured so that density bonuses in the receiving districts are awarded in exchange for cash deposits into a dedicated fund that is used to purchase conservation easements from willing property owners in the sending area. In general, voluntary TDR programs are not very effective and a partial or mandatory TDR program (see above) is recommended.

Leasing or Lease-Purchase

As an alternative to purchasing a fee-simple or development right interest in a property, land can be leased to prevent development or to preserve it for open space uses. This technique can be useful to preserve land in the short-term to provide additional time to obtain acquisition capital or make a decision regarding purchase. Property can also be leased through a lease-purchase agreement. This option can spread payments out over time if a local jurisdiction does not have enough capital to purchase the land outright.

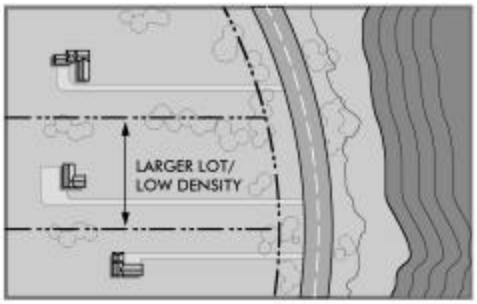
Land exchange

Local jurisdictions may exchange land that they own for land that they want to preserve from development.

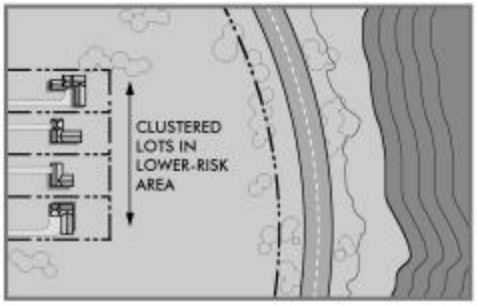
Restrict Development through Land Use Regulations

In areas where it is not feasible to restrict land uses to open-space uses, other land use planning measures can be used. These include strategically controlling the type of development and uses allowed in hazard areas, and avoiding high-value and high-occupancy uses to the greatest degree possible.

For example, plan designations and zoning districts can use density restrictions or large-lot zoning (e.g., 10-acre minimum) to ensure that only very low-density residential uses are allowed in hazard areas. Another technique is to require clustering of development on site areas where risks are the lowest. These site planning and design issues are addressed in more detail in Background Paper #4.



Large lot zoning can ensure that only very low density residential uses are allowed in hazard areas.



Development can be clustered on site areas where risks are the lowest.

Support Land Use Planning through Capital Improvement Planning and Budgeting

The capital improvement planning and budgeting process can be used to reinforce land use planning policies. A major factor in determining future development patterns is where a local jurisdiction chooses to extend sewer and water lines, roads, and other public facilities and services. These decisions can either discourage or encourage development in tsunami and other hazard areas.

It is important that capital improvement planning for public infrastructure is closely coordinated with land use planning programs to avoid hazard areas. Maximizing the safety of public

infrastructure also increases a community's ability to recover from disaster and restore essential public services as quickly as possible. Natural hazard risk mitigation should be integrated into infrastructure policy. Infrastructure policies by themselves will not restrict development from certain areas, but they can reinforce existing land use plans, and they shape market forces to encourage development in less hazardous areas by not subsidizing infrastructure costs to serve high-risk hazardous areas.

Adapt Other Programs and Requirements

The safety element of a comprehensive plan and the zoning, subdivision, and other programs designed to implement the comprehensive plan may contain regulations that are applicable to tsunami risk mitigation even if tsunami hazards are not mentioned explicitly. Many of these programs and regulations can be adapted relatively easily to address tsunami hazards. For example, existing floodplain restrictions, hillside and landslide controls, and environmental, scenic, recreational, and wildlife-protection requirements can help address potential tsunami hazards and should be modified for that purpose.

Local jurisdictions should review these programs and requirements for their contribution to tsunami loss reduction and modify them, as necessary, to explicitly address tsunami hazards. Appendix 3-1 contains the Honolulu Flood Hazard District Ordinance as an example of an ordinance that addresses tsunami and flood hazards in an integrated manner.

APPENDIX 3-1:
HONOLULU FLOOD HAZARD DISTRICT ORDINANCE

Revised Ordinances of the City and County of Honolulu 1990, Chapter 21 - Land Use Ordinance, Article 9 - Special District Regulations

Sec. 21-9.10 Flood hazard districts. Purpose.

(a) Certain areas within the city are subject to periodic inundation by flooding and/or tsunami which may result in loss of life and property, creation of health and safety hazards, disruption of commerce and governmental services as well as extraordinary public expenditures for flood and tsunami protection and relief.

(b) The purposes of establishing flood hazard districts are to protect life and property and reduce public costs for flood control and rescue and relief efforts, thereby promoting the safety, health, convenience and general welfare of the community. (Added by Ord. 99-12)

Sec. 21-9.10-1 Authority.

This section is enacted pursuant to the U.S. National Flood Insurance Act of 1968 Public Laws 90-448 and 91-152), as amended, and the U.S. Flood Disaster Protection Act of 1973 (Public Law 93-234), as amended. (Added by Ord. 99-12)

Sec. 21-9.10-2 Establishment of districts.

(a) Flood Hazard Districts. This section shall apply to all lands within the flood hazard districts delineated on the flood insurance rate maps, as prepared by the Federal Insurance Administration, Federal Emergency Management Agency. The following flood hazard districts are established:

(1) Floodway district;
(2) Flood fringe district;
(3) Coastal high hazard district;
(4) General floodplain district.

(b) The flood hazard districts are delineated on the flood insurance rate maps and any amendments by the Federal Emergency Management Agency, on file with the department, and which hereinafter are called flood maps.

(c) The flood boundary and regulatory flood elevations shall be determined by the flood maps. Where interpretation is needed as to whether or not a project lies within a certain flood district, or interpretation is needed on the regulatory flood elevation in the floodway, flood fringe or coastal high hazard districts, a request for interpretation shall be submitted to the director for determination. The request shall include the project site and location plan, property lines and dimensions and tax map key.

(d) Where interpretation on the regulatory flood elevation or other data are needed, other than as stated in subsection (c), the director with the recommendation of the chief engineer shall make the determination. The request for interpretation under this section shall be submitted to the director and include three sets of documents, stamped and signed by a registered professional engineer, containing adequate information and substantiating data consistent with this part, such as flood study, flood data, project site and location plan, property lines and dimension, tax map key, and topographic data, contours or spot elevations based on reference marks on flood maps. Upon review by the director, other related information may be required to evaluate the request. (Added by Ord. 99-12)

Sec. 21-9.10-3 Warning and disclaimer of liability.

(a) The degree of flood and tsunami protection required by the flood hazard districts is considered reasonable for regulatory purposes and is based on standard engineering methods of study. Larger floods or tsunamis than the regulatory flood as designated on the flood maps may occur on occasions, or flood or tsunami elevations may be increased by man-made or natural causes. This section does not imply that areas outside the flood hazard area will be free from flooding or damage.

(b) This section shall not create liability on the part of the city or any officer, official or employee for any flood or tsunami damages that result from reliance on this part or any administrative decision lawfully made thereunder. (Added by Ord. 99-12)

Sec. 21-9.10-4 Development standards.

Developments within the flood hazard districts shall:

(a) Be designed and structures adequately anchored to resist flotation, collapse or lateral movement resulting from hydrodynamic and hydrostatic loads, including effects from buoyancy caused by the regulatory flood.

(b) Use construction materials and equipment that are resistant to flood damage caused by the regulatory flood elevation.

(c) Use construction methods and practices that will minimize damage caused by the regulatory flood.

(d) Be consistent with the need to minimize damage by the regulatory flood to the best available technological and practical design and construction.

(e) Provide utilities and facilities (including but not limited to sewers, water, electric, telephone and gas) to be designed, located and constructed to minimize or eliminate flood damage caused by the regulatory flood.

(f) Provide drainage to minimize damage by the regulatory flood in accordance with the storm drainage standards of the department.

(g) For new or replacement potable water system and facilities, be designed to minimize or eliminate infiltration of flood waters into the systems.

(h) For new or replacement sanitary sewer system and waste disposal system, be designed, located and constructed so as to minimize impairment to them or contamination from them during and subsequent to flooding by regulatory flood. (Added by Ord. 99-12)

Sec. 21-9.10-5 Floodway district.

(a) Within the floodway district, the following uses having a low flood damage potential and not obstructing the regulatory flood shall be permitted as under the underlying zoning district and which are not prohibited by any other laws or ordinances; and provided, they do not affect the capacity of the floodway or any tributary or any other drainage facility or system:

(1) Public and private outdoor recreational facilities, lawn, garden and play areas;
(2) Agricultural uses including farming, grazing, pasture and outdoor plant nurseries;
(3) Drainage improvements, such as dams, levees, channels and bridges.

(b) Temporary or permanent structures, fill, storage of material or equipment or other improvements which affect the capacity of the floodway or increase the regulatory flood elevations shall not be allowed. Construction and improvements shall be subject to documentation by studies and data by a registered professional engineer that, to the best available technical knowledge and information, encroachment shall not result in any increase in the regulatory flood elevations during occurrence of the regulatory flood. (Added by Ord. 99-12)

Sec. 21-9.10-6 Flood fringe district.

(a) Within the flood fringe district, the uses permitted in the underlying zoning district shall be permitted, provided such uses, improvements, structures and utilities are in compliance with the provisions of Sections 21-9.10 through 21-9.10-14.

(b) In addition to Section 21-9.10-4, the following standards shall be applicable in the flood fringe district:

(1) All construction and improvements of residential structures shall have the lowest floor including basements, but not including floors used for access purposes such as stairways, storage purposes, garages, carports and lanais, elevated to or above the regulatory flood elevation. Maximum height in country, agricultural or residential districts may be exceeded by no more than five feet, provided such additional height shall not be greater than 25 feet above the regulatory flood elevation. This provision shall also apply to detached dwellings and duplex units in apartment and apartment mixed use districts.

(2)(A) All construction and improvements of nonresidential structures shall have the lowest floor elevated to or above the regulatory flood elevation; or, together with attendant utility and sanitary facilities, be designed and constructed so that below the regulatory

flood elevation, the structure is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy due to the regulatory flood.

(B) A registered professional architect or engineer shall develop or review the design, specifications and plans and certify that the design and methods of construction are in accordance with accepted standards of practice for meeting the provisions of this section and include the specific elevation to which such structures are floodproof.

(3) The structure above the regulatory flood elevation shall be securely anchored to the foundation to resist movement and flotation due to the regulatory flood.

(4) All construction, improvements, portions of structures and foundations below the regulatory flood elevation shall be designed to be floodproof, anchored to resist movement and flotation and be able to resist the impact and calculated forces of the regulatory flood.

(5) (A) In areas of shallow flooding, as designated on the flood maps as AO zone, all construction and improvements of residential structures, including but not limited to dwelling or lodging units, shall have the lowest floor, including basements, elevated above the highest adjacent grade at least as high as the depth number specified on the flood maps. All new construction and improvements of nonresidential structures within the AO zone shall have the lowest floor elevated above the highest adjacent grade at least as high as the depth number specified on the flood maps; or, together with attendant utility and sanitary facilities, be completely floodproof to or above that level so that any space below that level is watertight with walls substantially impermeable to the passage of water and with structural components having the capacity of resisting hydrostatic and hydrodynamic loads and effects of buoyancy.

(B)A registered professional architect or engineer shall develop or review the design, specifications and plans and certify that the design and methods of construction are in accordance with accepted standards of practice for meeting the provisions of this section and include the specific elevation to which such structures are floodproof. Highest adjacent grade means the highest natural elevation of the ground surface prior to construction and measured next to the proposed walls of the structure.

(6) All construction of fully enclosed areas for access purposes, storage, garages and carports below the regulatory flood elevation shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters. Designs for meeting these criteria must be certified by a registered professional engineer or architect, or provide a minimum of two openings having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding. The bottom of all openings shall be no higher than one foot above grade. Openings may be equipped with screens, louvers, valves or other coverings or devices provided that they permit the automatic entry and exit of floodwaters.

(7) Within the flood fringe district, the top of the lowest floor shall be at or above the regulatory flood, except for nonresidential floodproof structures. (Added by Ord. 99-12)

Sec. 21-9.10-7 Coastal high hazard district.

(a) Within the coastal high hazard district, the uses permitted in the underlying zoning district shall be permitted, provided such uses, improvements, structures and utilities are in compliance with the provisions of Sections 21-9.10 through 21-9.10-14.

(b) In addition to Section 21-9.10-4, the following standards shall be applicable in the coastal high hazard district:

(1)(A) All construction and improvements shall have the lowest floor, including basements, elevated to or above the regulatory flood elevation and securely anchored to piles or columns to resist movement and flotation and such foundation is able to resist the impact and calculated forces of the regulatory flood. Maximum height in agricultural, country or residential districts may be exceeded by no more than five feet, provided such additional height shall not be greater than 25 feet above the regulatory flood elevation. This provision shall also apply to detached dwellings and duplex units in apartment and apartment mixed use districts.

(B) Piles or column foundations and structures attached thereto shall be anchored to resist flotation, collapse and lateral movement due to the effects of wind and water loads acting simultaneously on all building components. Wind and water loading values shall each have a one percent chance of being equaled or exceeded in any given year.

(C) A registered professional architect or engineer shall develop or review the design, specifications and plans and certify that the design and methods of construction are in accordance with accepted standards of practice for meeting the provisions of Sections 21-9.10 through 21-9.10-14.

(2)(A) All construction and improvements shall have the space below the regulatory flood elevation reasonably free of obstruction or constructed with "breakaway walls," open wood latticework, or insect screening intended to collapse under wind and water loads without causing collapse, displacement or other structural damage to the elevated portion of the structure or supporting foundation.

(B) A breakaway wall shall have a design-safe loading resistance of not less than 10 and not more than 20 pounds per square foot, or a registered professional architect or engineer certifies that the breakaway wall shall collapse from a water load less than that which would occur during the regulatory flood. Such enclosed space shall be usable solely for parking of vehicles, building access or storage.

(3) The use of fill for structural support of buildings shall be prohibited.

(4) All new development shall be constructed landward of the reach of the mean high tide.

(5) Human alterations of sand dunes and mangrove stands which would increase potential flood damage shall be prohibited.

(6) Within the coastal high hazard district, the bottom of the lowest horizontal structural member of the lowest floor (excluding the pilings or columns) shall be at or above the regulatory flood. (Added by Ord. 99-12)

Sec. 21-9.10-8 General floodplain district.

(a) All proposed developments within the general floodplain district shall be subject to review and approval of the director. The application, signed and stamped by a registered professional engineer, shall include the following information to evaluate the flooding and to determine whether it is located on a floodway or flood fringe area:

(1) Project location and site plan showing dimensions, topographic data, contours or spot elevation based on reference marks on flood maps, relationship of project to floodway and flood fringe areas as determined by the flood study and existing and proposed control measures and requirements.

(2)(A) Flood study and drainage report, including cross section and profile of the area and the regulatory flood elevation and riverine flood velocities at the project.

(B) Upon review by the director, other information may be required to evaluate the flooding of the site.

(b) The director, with the recommendation of the chief engineer or other appropriate agency, shall evaluate and determine whether the proposed project is located within a floodway or flood fringe area and review the related flood data such as flood elevation, riverine flood velocities, boundaries, etc.

(c) If it is determined that the proposed project is within a floodway area, the project shall comply with the provisions and standards of the floodway district. If it is determined that the proposed project is within a flood fringe area, the project shall comply with the provisions and standards of the flood fringe district. Until a floodway or flood fringe district is designated, no development shall be allowed that would increase the water surface elevation of the regulatory flood more than one foot at any point.

(d) For developments in areas where the flood study and report have been previously reviewed and accepted by the city, the flood study and drainage report information may be waived by the director. (Added by Ord. 99-12)

Sec. 21-9.10-9 Developments adjacent to drainage facility outside the flood hazard district.

(a) Applications for building permits or development projects located on property encompassing or adjacent to a property with any stream, river or drainage facility shall be subject to review and approval of the chief engineer. Upon request by the chief engineer, the application shall

include information signed and stamped by a registered professional engineer, in accordance with Section 21-9.10-10, to evaluate the potential flooding of the area.

(b) If it is determined that the proposed project is within a floodway area, the project shall comply with the provisions and standards of the floodway district. If it is determined that the proposed project is within a flood fringe area, the project shall comply with the provisions and standards of the flood fringe district.

(c) No drainage facility, river or stream shall be modified, constructed, lined or altered in any way unless approved by the chief engineer. (Added by Ord. 99-12)

Sec. 21-9.10-10 Application procedures.

(a) All permits required by this chapter regarding subdivisions and other projects within the flood hazard districts shall include the stamp, signature and the following statements of a registered professional engineer and/or architect that, to the best available technical knowledge and information:

(1) The studies, plans, specifications and other documents comply with the standards of the flood hazard district. The structural design, specifications and plans for the construction have been developed or reviewed, and the design and methods of construction to be used are in accordance with accepted standards of practice for meeting the provisions of the flood hazard district.

(2) The floodproofing measures are consistent with the regulatory flood elevation.

(3) The project is adequate to resist the regulatory flood forces.

(4)(A) Structures in the coastal high hazard district are securely anchored to adequately anchored pilings or columns in order to resist the forces of the regulatory flood and not adversely affect the regulatory flood on surrounding properties.

(B) Information shall also include the location of the flood hazard boundaries; location, dimensions and elevations of the property in relation to elevation reference marks on flood maps; regulatory flood elevations, velocity and data; location and elevations of existing and proposed structures, utilities, streets and improvements; and the existing and proposed floodproofing measures and improvements.

(C) Development applications within the general flood plain district shall include the flood documents which were reviewed and accepted by the director.

(D) Whenever applicable, the flood hazard district requirements of a development project shall be determined prior to processing for other approvals mandated by other laws and regulations. (Added by Ord. 99-12)

Sec. 21-9.10-11 Flood hazard variance.

(a) The following, as permitted by other ordinances and regulations, unless otherwise stated, may be permitted as a flood hazard variance from Sections 21-9.10 through 21-9.10-14 subject to review and approval of the director:

(1) New structures, except in the floodway district, which are to be erected on a lot of one-half acre or less in area, contiguous to and surrounded by lots with existing structures constructed below the regulatory flood elevation;

(2) Uses, structures and standards in the floodway district as permitted under the underlying zoning district, which do not result in any increase in the regulatory flood elevation;

(3) Standards in the flood fringe and coastal high hazard districts, except for height standards.

(b) The application shall be submitted to the director and signed and stamped by a registered professional architect or engineer, and shall include three sets of documents with the following information as may be applicable:

(1) Plans and specifications showing the site and location; dimensions of all property lines and topographic elevation of the zoning lot; existing and proposed structures and improvements, fill, storage areas; location and elevations of existing and proposed streets and utilities; floodproofing measures; relationship of the site to the location of the flood boundary; and the existing and proposed flood control measures and improvements.

(2) Cross sections and profile of the area and the regulatory flood elevations and profile based on elevation reference marks on flood maps.

(3) Flood study and drainage report in areas where study and report have not been reviewed and accepted by the city.

(4) Description of surrounding properties and existing structures and uses and the effect of the regulatory flood on them caused by the variance.

(5) Justification and reasons for the variance with consideration of the intent and provisions of this part and information as may be applicable on the following:

(A) The danger to life and property, including surrounding properties due to increased flood elevations or velocities caused by the variance.
(B) The danger that materials may be swept on to other lands or downstream to the injury of others.
(C) The proposed water supply and sanitation systems and the ability of these systems to prevent disease, contamination and unsanitary conditions.
(D) The susceptibility of the proposed facility and its contents to flood damage and the effect of such damage on the individual owners.
(E) The importance of the services provided by the proposed facility to the community.

(F) The availability of alternative locations not subject to flooding for the proposed use.
(G) The compatibility of the proposed use with existing development anticipated in the foreseeable future.
(H) The relationship of the proposed use to the flood plain management program for the area.
(I) The safety of access to the property in times of flood for ordinary and emergency vehicles.
(J) The expected elevations and velocity of the regulatory flood expected at the site due to the variance.
(K) That failure to grant the variance would result in exceptional hardship to the applicant.
(L) That the variance will not result in increase to the regulatory flood elevations, additional threat to surrounding properties and to public safety, extraordinary public expense or conflict with other laws or regulations.

(6) An agreement whereby a covenant will be inserted in the deeds and other conveyance documents of the property and filed with the bureau of conveyances of the State of Hawaii that the property is located in a flood hazard area and is subject to flooding and flood damage. The covenant shall contain a statement that a flood hazard variance to construct a structure below the regulatory flood elevation will result in increased premium rates for flood insurance and such construction below the regulatory flood elevation increases risks to life and property. The covenant shall also state that the property owner or owners will not file any lawsuit or action against the city for costs or damages or any claim, and shall indemnify and save harmless the city from any liability when such loss, damage, injury or death results due to the flood hazard variance and the flooding of the property. Upon approval of the flood hazard variance, such covenants shall be fully executed, and proof of filing with the bureau of conveyances shall be submitted to the director prior to issuance of any building permits.

(7) Such other factors which are relevant to the purposes of this section.

(c) The director shall refer the request to the chief engineer, building superintendent or other appropriate agency for their comments and recommendations. A flood hazard variance may be granted upon showing of good and sufficient cause, and determination that (1) failure to grant the variance would result in exceptional hardship to the applicant; (2) the variance will not result in increase to flood elevations, additional threat to public safety, extraordinary public expense or conflict with other laws or regulations, except as otherwise stated; and (3) a variance granted within a floodway district would not result in increase of the regulatory flood elevation. The director may approve, approve with conditions or deny the application. Such conditions may include:

(1) Modification of the project, including the sewer and water supply facilities.
(2) Limitations on periods of use and operation.
(3) Imposition of operational controls, sureties and deed restrictions.
(4) Requirements for construction of channels, dikes, levees and other flood-protective measures.

(5) Floodproofing measures designed consistent with the regulatory flood elevation, flood velocities, hydrostatic and hydrodynamic forces and other factors associated with the regulatory flood.
(6) Other conditions as may be required by the director. (Added by Ord. 99-12)

Sec. 21-9.10-12 Nonconforming structures within the flood hazard districts.

(a) Any nonconforming structures which were previously lawful prior to the effective date of the flood hazard districts but which are not in conformity with them, may be continued subject to the following conditions:

(1) Repairs and Maintenance. Exemption from the standards of the flood hazard districts shall be permitted for any repair and maintenance work done on any nonconforming structure; provided that the cost of the work done in any period of 12 consecutive months is less than 50 percent of the replacement value of the structure before the work is started, and, if the structure has been damaged and is being restored, that the cost of restoring the structure to its previous condition is less than 50 percent of the replacement value of the structure before the damage occurred.

(2) Damage, Destruction or Demolition. Reconstruction and improvements shall be permitted on any nonconforming structure that is damaged, destroyed, or demolished to the extent that the cost of restoring the structure to its before-damage condition equals or exceeds 50 percent of the replacement value of the structure before the damage or demolition occurred; provided:

(A) The entire structure is reconstructed in conformity with the standards and provisions of the flood hazard district in which it is located;
(B) The damage or demolition occurred within the previous 12 months; and
(C) Reconstruction and improvements within the floodway district shall comply with the standards and provisions of the flood fringe district, and a registered professional engineer shall submit documentation showing that to the best technical knowledge and information, the reconstruction will not increase the regulatory flood elevations that existed during existence of the nonconforming structure.

(3) Exterior Improvements to an Existing Structure. Exemption from the standards of the flood hazard district shall be permitted for any exterior alteration, addition, or remodeling to any nonconforming structure; provided that the cost of the work done in a period of 12 consecutive months is less than 50 percent of the replacement value of the existing structure before the work is started. This cost includes all work, including repairs and maintenance as stated above.

(4) Relocation. If a nonconforming structure is relocated, it shall thereafter conform to the applicable flood hazard district standards, except that any nonconforming structure relocated within the same floodway district shall be exempt from the floodway district standards, subject to the following requirements:

(A) The nonconforming structure is relocated within the same zoning lot within the floodway district;
(B) The relocated structure shall comply with the standards and provisions of the flood fringe district; and
(C) A registered professional engineer shall submit documentation showing that to the best technical knowledge and information, the relocation will not increase the regulatory flood elevations that existed prior to relocation of the nonconforming structure.

(b) Every application for an exemption involving repair, reconstruction, exterior improvements, or relocation for a nonconforming structure in the coastal high hazard or floodway districts, as provided in subsection (a), shall be subject to the following:

(1) Within the coastal high hazard district, a registered professional engineer or architect shall develop or review the design, specifications, and plans and certify that the design and methods of construction are in accordance with accepted standards of practice, and that the structures and improvements would not affect the regulatory flood nor aggravate existing flood-related erosion hazards; or

(2) Within the floodway district, a registered professional engineer or architect shall develop or review the design, specifications, and plans and certify that the design and methods of construction are in accordance with accepted standards of practice, and that the structures and improvements would not result in any increase of the regulatory flood levels. (Added by Ord. 99-12)

Sec. 21-9.10-13 Exemptions.

(a) The following structures and improvements shall be exempted:
(1) Structures listed on the national register of historic places or state inventory of historic places for reconstruction, rehabilitation, or restoration;
(2) Fences and retaining walls;
(3) Interior renovations and improvements;
(4) Repair and maintenance to strengthen or restore any existing building or structure to a safe condition, as declared to be unsafe by an official charged with protecting the public safety;
(5) Demolition;
(6) Outdoor swimming pools;
(7) Signs;
(8) Temporary structures and uses incidental to building construction or land development;
(9) Carnivals, circuses, luaus, and fairs, and camping tents of a temporary nature;
(10) Storage sheds for agricultural, lawn equipment, and other similar storage sheds, including garages and carports;
(11) Streets, roadways, off-street parking lots, including private driveways, bridges and walkways;
(12) Bathhouses, comfort stations, open park pavilions, boathouses, picnic tables and benches, playground equipment, recreational open play courts, and recreational outdoor lighting and landscaping;

(13) Seawalls, bulkheads, wharves, piers, and docks; and
(14) Other structures similar to those as stated above which meet the intent and purpose of this section as determined to be exempt by the director.

(b) Structures and improvements listed under subdivisions (2), (3), (8), and (10) through (14) of subsection (a) shall not be exempted in the coastal high hazard or floodway districts except as follows:

(1) Within the coastal high hazard district, a registered professional engineer or architect shall develop or review the design, specifications, and plans and certify that the design and methods of construction are in accordance with accepted standards of practice and that the structures and improvements would not affect the regulatory flood nor aggravate existing flood-related erosion hazards.

(2) Within the floodway district, a registered professional engineer or architect shall develop or review the design, specifications, and plans and certify that the design and methods of construction are in accordance with accepted standards of practice and that the structures and improvements would not result in any increase of the regulatory flood levels. (Added by Ord. 99-12)

Sec. 21-9.10-14 Other laws and regulations.

All construction and improvements subject to this section shall comply with other applicable laws and regulations including, but not limited to, the building, housing, plumbing and electrical codes, and grading ordinances. This section, designed to reduce flood losses, shall take precedence over any less restrictive, conflicting laws, ordinances or regulations. (Added by Ord. 99-12)